M.Sc. 3rd Semester Examination, 2023

APPLIED MATHEMATICS WITH OCEANOLOGY AND COMPUTER PROGRAMMING

(*Operational Research Modelling-I*)

PAPER – MTM-306B(Old)

Full Marks : 50

Time : 2 hours

The figures in the right hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

1. Answer any *four* questions of the following : 2×4

(*a*) What is the dynamic inventory model ?

(*b*) Define the terms: 'Individual Replacement Policy' and 'Group Replacement Policy'.

(*c*) What is supply chain management ?

(*d*) State Bellman's principle of optimality.

(*e*) What are the critical paths and critical activities in network analysis ?

(*f*) What is simulation ? Describe its advantages in solving the problems.

2. Answer any *four* questions of the following : 4×4

(*a*) For an equipment, maintenance is a function increasing with time and scrap value is constant. Ignoring the time value of money and considering the interest rate as zero, find at what time it is advisable to replace the equipment.

(*b*) A baking company sells cake by its weight in kg. It makes a profit of Rs. 4.00 on every kg sold on the day it is baked. It disposes of all cakes not sold on the date they are baked, at a loss of Rs. 1.00 per kg. If the demand is known to be the

rectangular distribution between 2000 and 4000 kgs, determine the optimal daily amount baked.

(*c*) Write short notes on the following terms: Replenishment, Planning horizon, Shortages cost, Lead time and Backlogged.

(*d*) Explain the Monte Carlo simulation. State different mathematical steps in the Monte-Carlo method.

(*e*) Obtain the functional equation for solving the following problem by dynamic programming problem

Maximize $z = g_1(x_1) + g_2(x_2) + ... + g_n(x_n)$

Subject to $x_1 + x_2 + ... + x_n = c$

$x_1, x_2, ..., x_n \geq 0$.

(*f*) Write down the rules to construct a network. Also, describe the process of numbering the events in network analysis.

3. Answer any *two* questions of the following : 8×2

(*a*) At time zero, all the items in a system are new. Each item has a probability p of failing immediately before the end of the 1st month of life and probability $q,(=1-p)$ of failing immediately before the end of 2nd month. If all items are replaced as they fail, how that the expected number of failures $f(x)$ at the end of x month is given by

$$f(x) = \frac{N}{1+q}\left[1-(-q)^{x+1}\right],$$

where N be the number of items in the system.

If the cost per item of individual replacement policy is C_1 and the cost per item of group replacement policy is C_2. Find the conditions under which

(*i*) A group replacement policy at the end of 1st month is most profitable.

(*ii*) A group replacement policy at the end of 2nd month is most profitable.

The above group replacement policies (i) and (ii) are not better than the individual replacement policy.

(*b*) With the appropriate assumptions, derive the optimal inventory policies for the inventory system in which consumer's demand is a linear function of time. Hence, derive the optimal inventory policies for constant demand.

(*c*) A project consists of eight activities with the following relevant information.

Activity	Time estimates (days)			Predecessor
	t_0	t_m	t_p	
A	1	1	7	None
B	2	4	7	None
C	2	2	8	None
D	1	1	1	A
E	2	5	14	B
F	2	5	8	C
G	3	6	15	D, E
H	1	2	3	F, G

(*i*) Draw the network and find the expected project completion time

(*ii*) What is the probability of completing the project 4 weeks before the expected completion time ?

(*d*) Find the inventory policy for probabilistic inventory model with uniform demand and no set up cost inventory system. 8

[Internal Assessment — 10 Marks]